veoneer

11 January 2021

Docket Management Facility. M-30
U.S. Department of Transportation
1200 New Jersey Avenue SE
West Building Ground Floor
Room W12-140
Washington, DC 20590

Subject: RFI Impaired Driving Technologies

Veoneer, Inc. *is a worldwide leader in automotive technology. Our purpose is to create trust in mobility. We design, manufacture, and sell state-of-the-art software, hardware, and systems for occupant protection, advanced driving assistance systems, and collaborative and automated driving to OEMs globally.*

Veoneer is providing comments to this published document as requested to convey how we see this development in the market today and some of the avenues on addressing impaired driving moving forward in the automotive space. Veoneer's focus has been, up to this date, the understanding of driver awareness with states such as distraction and drowsiness. This, coupled with our collaborative driving efforts, is driving Veoneer toward a more holistic understanding of the driver, vehicle, and the environment. (Creating Trust in Mobility | Veoneer)

Our hope is that this document will provide some understanding of how Veoneer views the state of driver monitoring technology, and how we look to continue developing and improving in this space. As an active safety spin-off of Autoliv, one of the initial developers within the DADSS program, Veoneer has focused on vision based systems toward monitoring the driver.

This document will not go into confidential information or current data associated with future developments, but further discussion and details may be made available in a more appropriate venue.

CURRENT STATE OF VISION BASE SYSTEMS for AUTOMOTIVE APPLICATION (TRL level 9)

In 2020, Veoneer sucessfully launched our first camera-based monitoring system to the market. The technological leap for this system was in using a true eye gaze system, which determines the directional attributes of where the eyes are focused. Current market technology uses head pose and eye opening information to infer driver gaze. Veoneer is aware of various developments products that advertise focusing more in depth on eye attributes to determine impairment levels such as drugs and alcohol, but have yet to see the performance validation of these systems, or the "truthing" required to develop and test such systems.

Current Features Available in direct sensing (vision-based) Driver Monitoring Systems:

- Attention
    - Where Driver is looking based on "driving related" and "non-driving related" zones
- Distraction
    - Long Glance (single-glance)
    - Visual Time Sharing (multi-glance)
- Drowsiness
    - Based on KSS Scale
    - Microsleep
- Identification (TRL8)
    - Driver Identification
    - Data contained within vehicle for privacy

Veoneer US, Inc.
26360 American Drive
Southfield, Michigan 48034 U.S.A.

Teams: +1 (248) 440-2464
Mobile: +1 (586) 713-8021
tom.herbert@veoneer.com

ONGOING DEVELOPMENT PLANNING / PRE DEVELOPMENT – IMPAIRED DRIVING

"Impairment" while driving spans a wide variety of states. At the simplest, the current features of driver distraction and drowsiness are types of impairment; at the most complex, drivers who are drunk, drugged, or experiencing a sudden sickness" event (heart attack, stroke, insulin shock, etc), are also considered impaired. Detection of the specific complex states is mired in challenges of individualistic responses, ethical concerns with testing and validation of detection systems, the complexities of a moving vehicle environment, and most importantly, the immature state of the sensor landscape.

The consumer electronic, medical, and wearable fields have a myriad of sensors capable of detecting individualized and categorized impairment cases, but the automotive sector is unique in that sensors deployed on vehicles have to be characterized by a host of criteria. They must pass the rigorous automotive quality standards for robustness and durability, be able to meet performance criteria vehicle occupant diversity, and perform well under vehicle vibration, changing environmental conditions, and occupant movement.

In addition, the question of "what" to do when a state is detected cannot be ignored. For less severe cases such as distraction, the emphasis is put on notifications and warnings to bring the driver back to a safe and engaged driving state. For more severe cases, such as for "sudden sickness" or alcohol impairment, that approach is no longer possible. Veoneer's development and strategy has been centered around Collaborative Driving, as shown through our Learning Intelligent Vehicle (LIV), where the vehicle and driver work in tandem. The driver handles driving workload in situations that the vehicle cannot function, and vice versa, with the vehicle supporting and taking more control in situations where the driver is detected to be incapable. This approach becomes more and more powerful as vehicles on the market are increasingly equipped with systems that not only allow the vehicle to handle braking and longitudinal control, but also latitudinal control under rapidly expanding use cases of environmental conditions, road conditions, and geographical areas. These technologies, combined with driver monitoring systems, allows for situations where abnormal driving states can be detected, and the vehicle is able to take an escalating approach of notifications, warnings, and then control to resolve.

Given the severity of response that is possible with the highest escalation scenario, where a vehicle might need to perform a safety stop or disable the ability to drive entirely, systems must have a high degree of reliability and performance when it comes to diagnosis of severe impairment cases. Veoneer's position is that single-sensor or even multi-sensor detections alone for aspects such as BAC (Blood Alcohol Concentration), breath rate, heart rate, and electrodermal activity for classification of specific impairment categories such as drunk and drugged drivers are lacking not only in that the sensors are not ready for automotive deployment, but also in the fact that this strategy does not allow for the highest protection of drivers from the standpoint of crash and accident prevention.

Through our research in Collaborative Driving, we believe that the best solution resides in advanced algorithms that combine the detection of driver state with driving behavior, and understanding environmental and situational driving conditions to make the best decisions on how to aid the driver. Figure 1 below illustrations the three main aspects of the Collaborative Driving algorithm, with a non-comprehensive list of signals that serve as inputs for that portion of the algorithm. An attentive driver has behavioral characteristics that mark them as engaged, detectable both in the actual monitoring of the driver themselves, and also through their driving characteristics. In this scenario, unsafe attributes of drunk, drugged, or otherwise impaired drivers would be detected and flagged. Environmental information provides further insight into a driver's state, and valuable data in making a decision on the safest way to rectify a severe event. Veoneer's position is that this strategy helps maximize the impact of detecting and preventing unsafe behavior, therefore preventing a greater number of accidents and collisions over detection of single impairment categories alone.

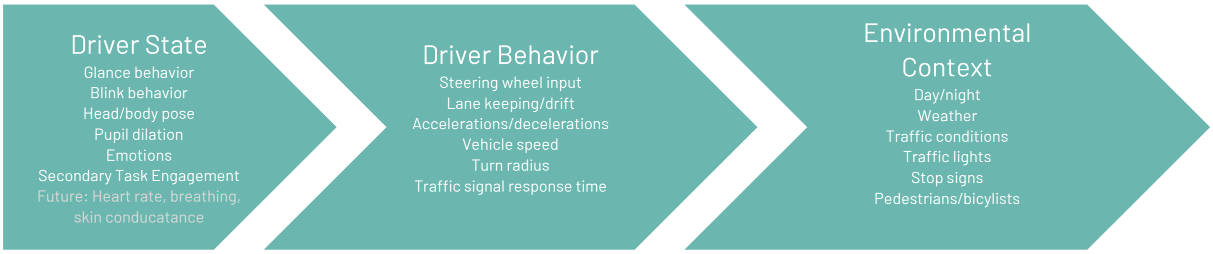

Figure 1: LIV Collaborative Driving – Algorithmic Inputs

In the future, it is Veoneer's position that technology maturation may enable the deployment of other biometric sensors to monitor aspect such as heart rate, breathing, and skin conductance, in order to provide data into a driver's state before any driving task is started. While Veoneer is actively developing and engaging with these technologies, the current state is that these sensors cannot yet provide the resolution nor the accuracy that is required for early impairment detection.

SENSORS/OTHER MODALITIES:

Veoneer's current position for detection of impairment cannot be accomplished with an acceptable level of confidence for an in-vehicle application using only a vision based system in the near future. Similar to the application of a police officer's administered vision-based test (FST – Field Sobriety Test) for alcohol impairment technology, this is only one part in the overall assessment of BAC (Blood Alcohol Concentration) levels. This test, the "Gaze Nystagmus," only shows a 77% accuracy level of having a BAC of > 0.10%[1]. If detection using visual cues is difficult for a trained police officer, the same level of difficulty, if not more, would be present for a vision-based detection system.

Veoneer's expectation is that multiple sensing modalities will be required to develop robust performance:

- Vision based system toward Driver
- Vision based system toward Enviroment (forward vision)
- Radar based system within vehicle
- Far-Infared Imaging
- Roadscape (Mapping / GPS)

Any additional sensors, such as ones that measure skin conductance, heart rate, electrodermal activity, or if alcohol is present on a driver's breath would only serve as additional signals to confirm a driver that cannot perform the driving task. This would only occur after maturation of the sensor technologies.

Key Challenges for Alcohol based impairment development

- "Naturalistic" data collection associated with key attributes
  - Dangerous conditions
  - Legality
- Privacy
  - For use of determination of normal vs current state
- Validation
  - Test sample size and variation
  - Confidence levels to an acceptable level
- Technology Maturity / Automotive Grade
  - Sensor development

In conclusion, Veoneer believes that detection of specific categories of impairment has two main downsides, 1) the level of accuracy and lack of maturity of the different automotive sensors available today and 2) does not account for the largest beneficial impact of preventing overall accidents on the road. Veoneer believes that customers and the general public will want to use, and benefit more from, a feature that determines overall state of driver's ability to drive. As such these systems, unlike product design in DDASS, will not be able to give a quick assessment prior to the driver starting the journey so steps for interaction will be needed up to a full safe harbor of the vehicle.

Sincerely

Caroline Chung
Sr. Manager Feature Development
Veoneer Inc.

Thomas J. Herbert
Director Product Planning
Veoneer Inc.